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Performance Evaluation of Concrete by using Waste Glass

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Abstract - *Glass is widely used in our lives through various products such as container glass, flat glass for windows, doors, partitions, mirrors, table tops, automobile glass, bulbs, etc. After its use, glass waste is a major component of the solid waste stream. Presently only a small portion of the post-consumed glass has been recycled for re-use and a significant portion of the waste glass generated is sent to landfills. The glass is not a biodegradable product hence it is not environmental friendly. Therefore, using it for landfilling is undesirable. Glass is a recyclable material with high performances and unique aesthetic properties which makes it suitable for wide-spread uses. Glass re-cycling and re-use has started with the increased awareness and cost benefits. The objective of this study is to explore the possibility of using waste glass as replacement of coarse aggregate in concrete. Various studies indicate that waste glass can effectively be used as replacement for coarse aggregate without substantial change in its strength. This project aims to compare the strength of concrete made with different proportions of glass waste as aggregate as against the strength of concrete made of conventional aggregate. The study primarily focuses on determining the optimum coarse aggregate mix ratio to achieve acceptable strength with waste glass as coarse aggregate.*

Key Words: *Glass crystal, Glass waste, Glass aggregate.*

1. INTRODUCTION

Glass is a material which is used as a replacing component with coarse aggregate which is a very important material in concrete. Studies have shown use of waste glass in concrete which means that there is a chance that nearly all waste glass now being dumped can be ground and put to good use thereby providing sustainability by replacing natural aggregate resources with recycled material thereby saving on cost of concrete, wider range of aesthetic applications for concrete etc. With the increased use of glass panels especially in commercial buildings in place of brick/cement walls, interior partition walls & doors and in the making of furniture, glass have already replaced a small portion of conventional construction materials. With this development, in future there going to be good availability of waste glass that can be used as a partial replacement of aggregate in concrete.

Glass is widely used in our lives through manufactured products such as automobile glass, container glass, flat glass for windows, doors, partition walls, exterior walls, electrical bulbs, etc. Post its use, glass becomes a major component of solid waste in most places. A large quantity of useless glass residue by-products, and waste materials are produced by different industries on regular basis. Several studies have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to using as an aggregate in concrete. Sheet Glass waste is of large volume in the past few decades and it is increasing year after year. Using waste glass in the concrete construction sector is advantageous as the production cost of concrete will come down apart from giving relief from environmental pollution. This also means local council, recyclers, and private contractors can look at using glass concrete for a range of construction applications. Our study primarily focuses on producing concrete of acceptable strength with waste glass as coarse aggregate and determining the optimum coarse aggregate mix ratio to achieve desirable strength. Additionally, the study also aims to achieve a high architectural level by using glass aggregates as a decorative material in concrete.

2. MATERIAL COLLECTION

2.1 Cement:-

In this work, Portland Slag Cement (PSC) [IS455 - 1989] was used. The main reason of using PSC is that alkalis are lessened in concrete with incorporation of slag, thus chances of Alkali Silica Reaction (ASR) is reduced which was commonly observed between OPC and glass. The high volume slag concrete system is environment friendly and the concrete so produced also demonstrates the attributes of high performance concrete.

2.2 Fine Aggregate:-

Fine aggregates are an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of grain or particle, but is distinct from clays which contain organic minerals. Sands that have been sorted out and separated from the organic material by the action of currents of water or by wind across arid land are uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds. Much of the earth's surface is sandy, and the sand is usually quartz and other siliceous materials.

2.3 Coarse Aggregate:-

Coarse aggregates are the crushed stone used for making concrete. The commercial stone is quarried, crushed and graded. Much of the crushed stone used is granite, limestone and trap rock. Crushed angular granite metals from local sources are generally used as coarse aggregate. The coarse aggregate are granular materials obtained from rocks and crushed stones. They may be also obtained from synthetic material like slag, shale, fly ash and clay for use in light-weight concrete.

2.4 Water:-

Water is important in producing a cement paste and hydration of Portland cement. The determination amount of water is important because with excessive of water it will cause the concrete with higher slump and cause a free-flowing concrete. The less of amount of water is used, the higher the strength. The common specifications regarding quality of mixing water is water should be fit for drinking. Such water should have inorganic solids less than 1000 ppm. Water which is not potable may also be used in making concrete without any significant effect. Dark color or bad smell water may be used if they do not possess deleterious substances. pH of water to even 9 is allowed if it not tastes brackish.

2.5 Glass:-

Waste glass can be categorized into different types. The main variety of waste glass that is used for the strength development in this project is Toughened Glass. Toughened glass is 4/5 times stronger than annealed glass of the same size and thickness against impact. Toughened glass has higher thermal strength and can withstand a high temperature differential up to 250°C. Toughened glass is considered as safety glass. It is difficult to break and even in the event of a breakage, disintegrates into small globules, which are not harmful. These small globules are used as a replacement to coarse aggregates

2.6 Admixture:-

In this project, while casting of concrete, Sikament®-NN was used as an admixture. It is a highly effective dual action liquid super plasticizer for production of free flowing concrete and acts as a substantial water-reducing agent for promoting high early and ultimate strengths.

3. METHODOLOGY

Strength of concrete made of different proportions of glass waste as coarse aggregate was compared with the strength of conventional concrete at 28 days of moist curing to arrive at the optimum percentage of glass waste as replacement of conventional aggregates without affecting other properties of concrete. The percentages of aggregates and their replacement by glass waste in the trials conducted.

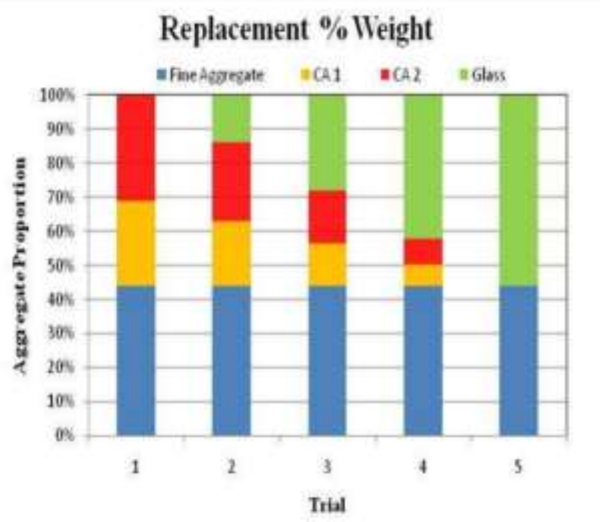

Chart -1: Replacement by Weight

3.1 Concrete Mix Design

Following table shows sample of mix design which is done to calculate exact quantities of the material.

Table -1: Sample of Mix design

Cement	350 kg/m^3
Water	140kg/m^3
Fine Aggregate	900.6kg/m^3
Coarse Aggregate	1142.7 kg/m^3
CA 1	510 kg/m^3
CA 2	633 kg/m^3
GA (0%)	0 kg/m^3
Chemical Admixture	0.0016667 kg/m^3
Water Cement Ratio	0.4

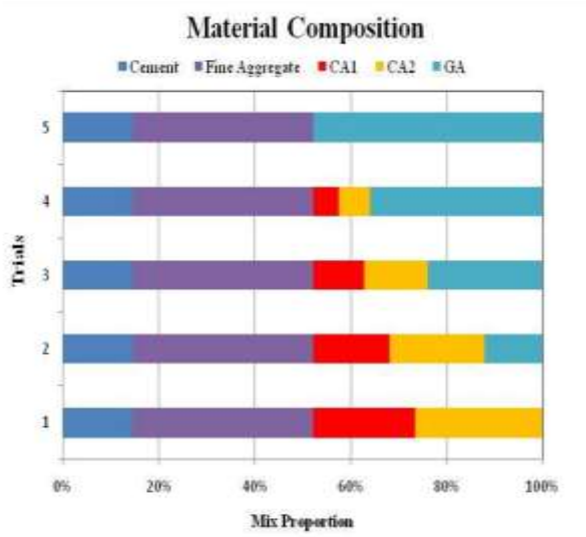

Chart -2: Material Composition

4. RESULTS AND DISCUSSION

4.1 Compressive strength

Compressive strength test was conducted according to IS 516-1959 on cubes of size 15 cm x 15 cm x 15 cm in Compression Testing Machine for 28 days.

Following table shows the results of compressive strength for 28 days.

Table -2: Compressive Strength Test results

Sr. No.	Glass (%)	Slump (mm)	Admixture (%)	28 Days			
				kN	Avg.	kN/m^2	Avg.
1	0%	80	0.20%	934	928	41.51	41.24
2				924		41.07	
3				926		41.16	
4	25%	110	0.20%	958	960	42.58	42.68
5				960		42.67	
6				963		42.80	
7	50%	130	0.20%	992	1000	44.09	44.44
8				1008		44.80	
9				1000		44.44	
10	75%	160	0.20%	861	856	38.27	38.06
11				854		37.96	
12				854		37.96	
13	100%	180	0.20%	717	734	31.87	32.64
14				733		32.58	
15				753		33.47	

4.2 Flexural strength

Beams of 15 cm x 15 cm x 75 cm were cast according to IS 516-1959 and tested for flexural strength.

Following table shows the results of strength for 28 days.

Table -3: Flexural Strength Test results

Sr. No.	Glass (%)	Admixture (%)	28 Days			
			kN	Avg.	kN/m2	Avg.
1	0%	0.20%	50	50	5.93	5.93
2			50		5.93	
3			50		5.93	
4	25%	0.20%	55	53	6.52	6.32
5			50		5.93	
6			55		6.52	
7	50%	0.20%	55	55	6.52	6.52
8			55		6.52	
9			55		6.52	
10	75%	0.20%	45	45	5.33	5.33
11			45		5.33	
12			45		5.33	
13	100%	0.20%	35	38	4.15	4.54
14			40		4.74	
15			40		4.74	

4.3 Split Tensile strength

Split Tensile Strength test was conducted on cylinders of diameter 15 cm and length 30 cm according to IS 5816-1999 at 28 days curing period.

Following table shows the results of Split Tensile.

Table -4: Split Tensile Strength Test results

Sr. No.	Glass (%)	Admixture (%)	28 Days			
			kN	Avg.	kN/m2	Avg.
1	0%	0.20%	65	60	0.92	0.85
2			60		0.85	
3			55		0.78	
4	25%	0.20%	75	77	1.06	1.09
5			75		1.06	
6			80		1.13	
7	50%	0.20%	75	78	1.06	1.11
8			80		1.13	
9			80		1.13	
10	75%	0.20%	35	35	0.49	0.5
11			40		0.56	
12			30		0.42	
13	100%	0.20%	25	27	0.35	0.38
14			30		0.42	
15			25		0.35	

5. COST COMPARISON

- When aggregate is replaced with 25% glass cullets the cost is reduced by 3.7% of the cost of CM
- When aggregate is replaced with 50% glass cullets the cost is reduced by 7.4% of the cost of CM.
- When aggregate is replaced with 75% of glass cullets the cost is reduced by 11.12% of the cost of CM.
- When aggregate is replaced with 100% of glass cullets the cost is reduced by 14.8% of the cost of CM.

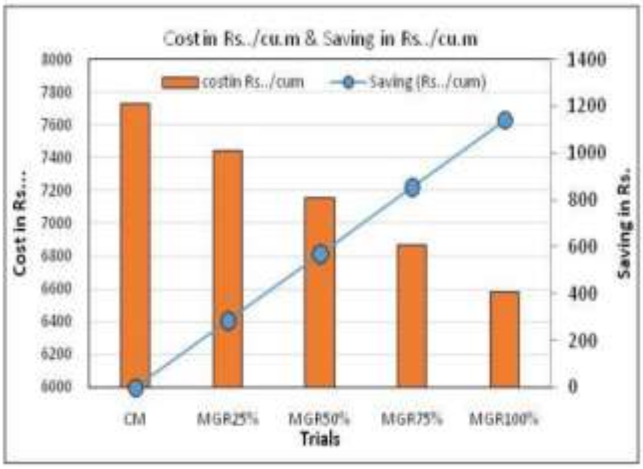

Chart -3: Cost Comparison

6. CONCLUSION

From the tests conducted, it can be seen that the inclusion of waste glass as a replacement to coarse aggregate can be done practically. To study its application an attempt was also made to add crushed colorful glass from waste bottles as aggregate to concrete. This was done to add aesthetic value to the concrete. The glass bottles were crushed and sieved to appropriate sizes and included along with the other toughened glass aggregate to concrete. After hardening of concrete, the surface layer of concrete was ground using a hand-held grinder. With better and smooth finish, it can be used for making architectural concrete, partition walls, counter table tops, or just normal concrete for structural works.

7. REFERENCES

[1] Jostin.P.Jose, S. Suganya, Banu Priya - “Use of Glass Powder As Fine Aggregate In High Strength Concrete” - International Journal of Science and Engineering Research Volume 02, July 2014.

[2] Simonetta L. Pagliolico, Annalisa Torta, Maurizio Giraud, Fulvio Canonico, Laura Ligi - “A Preliminary Studies on Light Transmittance Properties of Translucent Concrete Panels with Coarse Waste Glass Inclusions” - 6th International Building Physics Conference, 2015.

[3] Hongjian Du, Kiang Hwee Tan - “Waste Glass Powder as Cement Replacement in Concrete” - Journal of Advanced Concrete Technology, Volume 12, 2014.

[4] Shilpa Raju, Dr. P.R. Kumar - “Effect of Using Glass Powder in Concrete” - International Journal of Innovative Research in Science, Engineering and Technology, Volume 3, Special Issue 5, July 2014.

[5] M. Iqbal Malik, Muzafar Bashir, Sajad Ahmad, Tabish Tariq, Umar Chowdhary - “Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine Aggregates” - IOSR Journal of Engineering, Vol. 3, Issue 7, July 2013.

[6] Mohammad Shoeb Sayeeduddin , Mr. F.I. Chavan - “Use of Waste Glass Powder As A Partial Replacement of Cement In Fibre Reinforced Concrete” - IOSR Journal of Mechanical and Civil Engineering, Volume 13, Issue 4, August 2016.